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Tropical Important Plant Areas, plant species richness and conservation in the British Virgin Islands

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Abstract

The global loss of biodiversity is a pressing and urgent issue and halting loss is the focus of many international agreements and targets. However, data on species distribution, threats and protection are limited and sometimes lacking in many parts of the world. The British Virgin Islands (BVI), part of the Puerto Rican Bank Floristic Region in the Caribbean Biodiversity Hotspot, is rich in plant diversity and regional endemism. Despite the established network of National Parks in the BVI and decades of botanical data from international collaboration between the Royal Botanic Gardens, Kew and the National Parks Trust of the Virgin Islands, there was a need for consolidated data on species distribution across the archipelago and national lists for threatened and rare plants of conservation concern. The process of identifying the network of 18 Tropical Important Plant Areas (TIPAs) in the BVI, completed in 2018, delivered national lists and accurate data for all 35 Species of Conservation Concern. These data (3688 georeferenced records) are analysed here to reveal species distribution across the archipelago, within the TIPAs network and the National Parks System. The TIPAs network contained all 35 Species of Conservation Concern and 91% of all the records, as expected. Ten out of the 21 National Parks had one or more of the species present. Most species occur across the archipelago, while some are restricted range and/or endemics. These new data will help management of

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plant conservation efforts and resources in the BVI, contributing to the revision of the Protected Areas System Plan and local environmental policies and have relevance to the wider Caribbean Region.

Keywords

Caribbean, Important Plant Areas (IPAs), *in situ* conservation, protected areas, threatened species

Introduction

Nature is declining at an unprecedented rate and global wildlife populations have decreased by 68% since 1970 (WWF 2020). Estimates of global extinction rates are 100–1000× greater than in the geological past (Dasgupta 2021). The landmark report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) estimated that up to one million species may be threatened with extinction (IPBES 2019). Recent analyses have estimated that 2 in 5 plants are threatened with extinction with habitat loss due to agricultural expansion being the greatest single threat (Nic Lughadha et al. 2020). The global climate emergency (Ripple et al. 2020) is adding greater pressure to already vulnerable species and habitats (IPCC 2014). Conservation biologists are in a race against time to identify the most important areas of the world for wild species diversity and to focus resources towards protecting these sites. As we better understand that our economies, livelihoods and well-being all depend on Nature, there is greater support from the wider population for increased and urgent conservation interventions (Dasgupta 2021). Developing priorities for these conservation interventions has been the focus of much research targeting regional scale sites, such as Biodiversity Hotspots (Mittermeier et al. 1998; Myers et al. 2000) or discrete sites, such as Alliance for Zero Extinction sites (Ricketts et al. 2005). Other approaches target specific groups of taxa, such as Important Bird Areas (IBAs) (Donald et al. 2019) or concentrations of multiple taxa, such as Key Biodiversity Areas (KBAs) (KBA 2020). For plants, identifying Important Plant Areas (IPAs) (Darbyshire et al. 2017; Plantlife 2018), particularly in the tropics, has become an area of increased activity and the application of this methodology is the focus of this paper.

The Caribbean Region is estimated to contain 12% of the plant diversity and 29% of the medicinal plants (spermatophytes only) of the Americas in only 1% of the land area (IPBES 2018). The Puerto Rican Bank Floristic Region comprising the British Virgin Islands (BVI), the United States Virgin Islands (USVI) and the Commonwealth of Puerto Rico, is located in the Caribbean Biodiversity Hotspot (Myers et al. 2000) and has a diverse flora with 2,108 native taxa, of which 292 are regional endemics (Lugo et al. 2006; Acevedo-Rodríguez and Strong 2012). This endemism is partly explained by most of the floristic region previously being one landmass during the Last Glacial Maximum when sea levels were much lower (Lambeck et al. 2002; Renken et al. 2002; Siddall et al. 2003; Mann et al. 2005; Hamilton 2016) and the Caribbean proximity to South America, Mesoamerica and North America (Santiago-Valentin and Olmstead 2004; Acevedo-Rodríguez and Strong 2008). The

BVI itself is a tropical archipelago with a land mass of 153 km^2 with approximately 50 rocks, keys and islands and a native flora of 648 vascular seed plants, including four endemic taxa: *Vachellia anegadensis* (Britton) Seigler & Ebinger, *Metastelma anegadense* Britton, *Pitcairnia jareckii* Proctor & Cedeño-Mald. and *Senna polyphylla* var. *neglecta* H.S. Irwin & Barneby (Acevedo-Rodríguez and Strong 2012; The BVI TIPAs National Team 2019b).

Identifying species diversity and distribution is key to protection and prevention of biodiversity loss at a global and local scale, as robust data are paramount for well-informed decisions on policy, conservation and species management. However, it is important not only to identify which plant species occur in an area, but also their vulnerability to threats (e.g. loss of habitat, invasive species, pests), protection (e.g. protected areas, legal status) and conservation importance (e.g. endemic species, keystone species) to reduce loss of biodiversity and protect global biodiversity hotspots (Mittermeier et al. 2011). Extinction risk assessments, particularly of endemic species, are an important tool for prioritising conservation efforts and preventing biodiversity loss (Nic Lughadha et al. 2020). The only Caribbean UK Overseas Territory (UKOT) with a complete National Red List is the Cayman Islands which includes 415 taxa, with 46% of them being threatened with extinction (Burton 2008). Extinction risk assessments and botanical surveys are on-going in several of the Caribbean UKOTs and countries (Clubbe et al. 2020).

IPAs consider not only species distribution and botanical richness of an area, but also prioritise those plants and habitats under threat by identifying a network of key sites for the conservation of wild plants and threatened terrestrial habitats (Plantlife 2018). The guidelines developed by Plantlife for Europe (Anderson 2002) have been tested and implemented in many countries in the past two decades, mostly temperate regions in Europe and the Mediterranean (Atay et al. 2000; Anderson et al. 2005; RBG Kew 2016; Darbyshire et al. 2017; Willis 2017; Plantlife 2018). IPAs are key to Target 5 of the Convention on Biological Diversity (CBD) Global Strategy for Plant Conservation (GSPC) which aims to protect > 75% of the most important areas for plant diversity in each ecological region in the world (Secretariat of the Convention on Biological Diversity 2012; GSPC 2021).

The focus of IPAs identification has shifted recently to the tropics following a review of the IPAs guidelines (Darbyshire et al. 2017). Tropical Important Plant Areas (TIPAs) aim to extend the network of IPAs into the most biodiverse regions of the world. The TIPAs process includes participatory workshops with stakeholders (e.g. government bodies, NGOs, community members), botanical surveys, data consolidation, assessments of extinction risk and vegetation mapping. The resulting data on globally threatened species and regional/national species of conservation concern and their distribution, botanically rich areas and threatened habitats help deliver a strong and scientifically-sound framework for species and habitat conservation and management. In 2019, annotated checklists of threatened plant species for the Guinea-Conakry region in Guinea (Couch et al. 2019a) and Mozambique (Darbyshire et al. 2019) were produced using the TIPAs process and the first TIPAs of Tropical Africa were

identified in Guinea (Couch et al. 2019b). An endemic species list for the Ebo Forest in Cameroon, a proposed National Park, have been published during the TIPAs identification process, reinforcing the importance of this area for local conservation (Cheek et al. 2018). Preliminary work in the Caribbean UKOTs of the British Virgin Islands, the Turks and Caicos Islands and Montserrat, identified candidate sites for IPAs, but more extensive botanical surveys and a framework were needed to progress and complete a network of IPAs for these countries (Clubbe et al. 2020).

Despite their importance, levels of legal protection of IPAs and TIPAs vary widely from nearly 100% in the UK to below 50% in parts of North Africa and the Middle East (Willis 2017). Aichi Biodiversity Target 11 highlights the importance of effective and equitably managed protected areas as an important management tool to conserve biodiversity (CBD 2011). However, data on globally and nationally threatened species and habitats are not always available to assess biodiversity within protected areas (Watson et al. 2014). The BVI Protected Areas System Plan 2007–2017 (Gardner et al. 2008) concerns the established network of protected areas across the archipelago. However, the majority of these areas have been chosen, based on the ecosystem services they provide and fauna diversity, for example, watersheds, nesting sites for migratory birds, as only limited information on the flora was available at the time (Smith-Abbott et al. 2002; Pascoe et al. 2015).

This work complements the TIPAs process in the BVI and previous botanical research by presenting and analysing species richness and distribution of the Species of Conservation Concern and globally threatened species across the archipelago using all available high resolution botanical data. For the first time, species representation within the BVI TIPAs and National Parks are discussed and gaps in *in situ* conservation identified. Further, we discuss the implications of these findings to future species management, plant conservation and policy in the BVI. These findings have implications for the wider Caribbean Region.

Methods

Botanical data and species of conservation concern (SCC)

A target list of priority native plant species was compiled using baseline data from: 1) two decades of botanical work in the BVI by the National Parks Trust of the Virgin Islands (NPTVI); Royal Botanic Gardens, Kew, UK (Kew); and regional partners; 2) previous Red Listing work (Pollard and Clubbe 2003) and 3) botanical literature for the Puerto Rican Bank (Grisebach 1859; Eggers 1879; Urban 1898; Britton 1918; D'Arcy 1967, 1975; Little et al. 1976; Acevedo-Rodríguez 1996; Axelrod 2011), especially the 'Catalogue of Seed Plants of the West Indies' (Acevedo-Rodríguez and Strong 2012). The target list included species present in the BVI and in one or more of the following categories: a) globally threatened species included in the 2018 International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN

2018), b) endemic to the Puerto Rican Bank and c) restricted range species (Bárrios et al. 2017). Globally threatened species are those in one of the threatened categories of Vulnerable (VU), Endangered (EN) or Critically Endangered (CR). Restricted range species were defined as native plants which only occur in one country/territory or region with an Extent of Occurrence (EOO) < 10,000 km^2, following the concepts for TIPAs by Darbyshire et al. (2017) and the IUCN KBA Standard (KBA 2020).

A total of 3,688 high accuracy (+/- 10 m) georeferenced location records for 35 of the priority species were included in this analysis. Records were retrieved from the Kew UKOTs Species and Specimens Database (SSD) (UKOTsTeam 2021), which contains a compilation of records from herbaria (e.g. Kew, MAPR, MO, NY, SJ, UPRRP, US) and data from field surveys carried out by Kew and NPTVI between 2000 and 2018 across 23 islands of the BVI. Data were checked and duplicated location records for individual plants were excluded before retrieval from the database. Data were available for terrestrial vascular seed plants only.

Extinction risk assessments and re-assessments for 30 priority species were undertaken collaboratively by experts from Kew, NPTVI, University of Puerto Rico, US Fish and Wildlife Service (USFWS) Caribbean Ecological Services Field Office (CESFO) and Puerto Rico Departmento de Recursos Naturales y Ambientales (DRNA), following the IUCN standards and criteria methodology (IUCN Standards and Petitions Committee 2017). All assessments, except two for natural hybrids, were published in the IUCN Red List of Threatened Species. Five other priority species were not reassessed due to their wide distribution.

Tropical Important Plant Areas (TIPAs)

A series of workshops involving botanical experts, local conservation practitioners, Government representatives and community members, led by Kew and NPTVI, were held in the BVI in 2016 and 2017 to introduce and apply the TIPAs methodology (Darbyshire et al. 2017; Plantlife 2018), define fieldwork priorities through gap analysis and identify priority native plant species (The BVI TIPAs National Team 2019a).

The BVI national list of Species of Conservation Concern (a.k.a. species of high conservation importance) was agreed in 2018 and used in the TIPAs process (The BVI TIPAs National Team 2019a). The Species of Conservation Concern comprise native species listed as globally threatened in the 2018 IUCN Red List of Threatened Species (IUCN 2018) or restricted range species (EOO < 10,000 km^2). Species were assessed following the criteria detailed in Darbyshire et al. (2017) and applied by the BVI TIPAs national team (2019a). Globally threatened species were considered under TIPAs qualifying criterion A(i) - site contains one or more globally threatened species. Species of Conservation Concern were considered under TIPAs criteria A(iii) - site contains one or more highly restricted endemic species [EOO < 100 km^2] that are potentially threatened; A(iv) - site contains one or more range restricted endemic species [EOO > 100 km^2 and < 5,000 km^2] that are potentially threatened; and B(ii) - site contains > 10% of the species in the national list of Species of Conservation Concern

(i.e. four species) or is one of the 15 richest sites nationally. The thresholds for the restricted endemics align, respectively, to the CR and EN categories of the IUCN Red List assessments under criterion B (IUCN Standards and Petitions Committee 2017). Additional conditions for the site to qualify under Criterion A includes being one of the five best sites nationally for the species or contain > 1% of its global population or > 5% of its national population.

The TIPAs Network for the BVI was identified and agreed in 2018. Detailed description of the TIPAs sites identified and mapped, including qualifying criteria, were published during the TIPAs process (The BVI TIPAs National Team 2019a, 2019b).

All species records were added to a bespoke Geographic Information System (GIS) project in ArcGIS Desktop software (ESRI, version 10.1, Redlands, CA, USA), containing layers for the TIPAs network and National Parks for the BVI to enable data visualisation, querying and mapping (The BVI TIPAs National Team 2019a).

National parks

The 21 declared National Parks and eight Proposed National Parks used for the analyses presented in this paper correspond to the terrestrial National Parks in the BVI Protected Areas System Plan 2007–2017 (Gardner et al. 2008). The plan includes declared marine and terrestrial protected areas managed by NPTVI and proposed new sites with various levels of protection and management. Declared National Parks are referred to as National Parks in this paper.

Results

Data and distribution of species of conservation concern across the BVI

The BVI list of Species of Conservation Concern contains 35 species, all of them previously identified as target priority species. The Species of Conservation Concern comprise the 25 species assessed as globally threatened, plus ten national endemics and/or restricted range species with qualifying EOO (Table 1). These species were used for the identification of a network of 18 TIPAs across the archipelago (Fig. 1) (The BVI TIPAs National Team 2019a, 2019b).

A total of 3,143 records were from globally threatened species. The total number of records per species varied widely from one to over 900, with most species having < 40 records and two of the species, *Vachellia anegadensis* and *Varronia rupicola* (Urb.) Britton, having > 700 records (Table 1).

Species of Conservation Concern were distributed across 23 islands of the archipelago (Fig. 2) and no single island supported all the species. The highest number of SCC and records were found in the largest islands in the BVI: Tortola (23 SCC, 256 records, total island area 57 km^2), Anegada (14 SCC, 2206 records, 40 km^2), Virgin Gorda (17 SCC, 665 records, 22 km^2). All other islands had ten or fewer

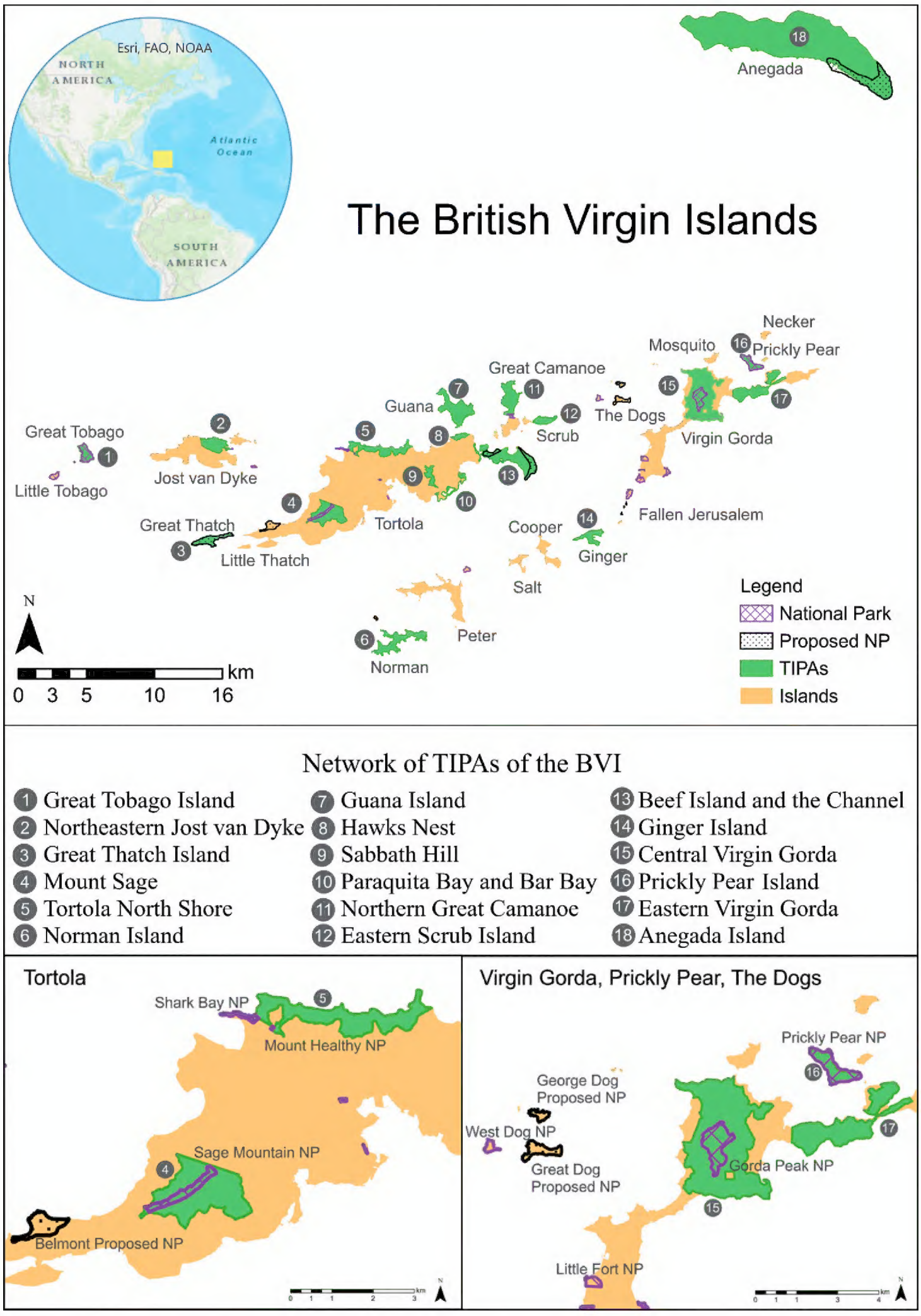

Figure 1. Map of TIPAs and terrestrial National Parks of the British Virgin Islands. Detailed maps at the bottom showing overlap of TIPAs and National Parks in those Islands. Abbreviations: Tropical Important Plant Areas (TIPAs), National Park (NP), Proposed National Park (Proposed NP).

Table 1. Species of Conservation Concern, their threat status, distribution and occurrence in TIPAs and National Parks. All species names according to Plants of the World Online Portal (POWO 2021). Globally threatened status according to IUCN criteria v. 13. IUCN assessments under synonyms for four species †*Bastardiopsis eggersii* (Baker f.) Fuertes & Fryxell, ‡*Calyptranthes kiaerskovii* Krug & Urb., §*Calyptranthes thomasiana* O.Berg and |*Acacia anegadensis* Britton. Abbreviations: Neotropics (NTROP), Caribbean Region (CARIB), Puerto Rican Bank Floristic Region (PRB), US and British Virgin Islands (VI), British Virgin Islands (BVI) and Puerto Rico (PR), Tropical Important Plant Areas (TIPAs), National Park (NP), Proposed National Park (PNP).

Species	Family	IUCN assessment	Endemism	Total records	TIPAs present	NP present	PNP present
Agave missionum Trel.	Asparagaceae	VU	PRB	220	11	4	2
Anthurium × *selloanum* K.Koch	Araceae	N/A	VI	11	2	2	
Argythamnia stahlii Urb.	Euphorbiaceae	VU	PRB	104	2		1
Abutilon virginianum Krapov.†	Malvaceae	EN	PRB	67	4	1	
Myrcia neokiaerskovii E.Lucas & K.Samra ‡	Myrtaceae	CR	BVI, PR	32	2	2	
Myrcia neothomasiana A.R.Lourenço & E.Lucas §	Myrtaceae	EN	VI	23	2	2	
Cedrela odorata L.	Meliaceae	VU	NTROP	1	1	1	
Croton fishlockii Britton	Euphorbiaceae	NT	VI	295	8	2	1
Erythrina eggersii Krukoff & Moldenke	Leguminosae	EN	PRB	11	2		1
Galactia eggersii Urb.	Leguminosae	NT	VI	34	5		1
Guaiacum officinale L.	Zygophyllaceae	EN	NTROP	15	1		1
Ilex urbaniana Loes. ex Urb.	Aquifoliaceae	VU	PRB	21	1	1	
Leptocereus quadricostatus (Bello) Britton & Rose	Cactaceae	EN	BVI, PR	33	1		1
Machaonia woodburyana Acev.-Rodr.	Rubiaceae	EN	VI	141	2		
Malpighia woodburyana Vivaldi	Malpighiaceae	VU	PRB	262	12	3	4
Maytenus cymosa Krug & Urb.	Celastraceae	EN	PRB	35	2	1	
Metastelma anegadense Britton	Apocynaceae	EN	BVI	212	2		1
Miconia thomasiana DC.	Melastomataceae	NT	BVI, PR	24	1	1	
Mitracarpus polycladus Urb.	Rubiaceae	EN	CARIB	36	1		
Peperomia wheeleri Britton	Piperaceae	EN	CARIB	7	2		
Picrasma excelsa (Sw.) Planch.	Simaroubaceae	VU	NTROP	1	1	1	
Pilea sanctae-crucis Liebm.	Urticaceae	EN	VI	16	3	2	
Piptocoma antillana Urb.	Asteraceae	LC	PRB	14	4	1	
Pitcairnia jareckii Proctor & Cedeño-Mald.	Bromeliaceae	EN	BVI	17	3		
Psychilis macconnelliae Sauleda	Orchidaceae	NT	PRB	35	9	1	2
Reynosia guama Urb.	Rhamnaceae	NT	VI	32	6	2	
Rondeletia pilosa Sw.	Rubiaceae	NT	PRB	60	9	2	2
Sabal causiarum (O.F.Cook) Becc.	Arecaceae	VU	CARIB	26	3	1	
Senna polyphylla var. *neglecta* H.S.Irwin & Barneby	Leguminosae	CR	BVI	78	1		1
Tillandsia × *lineatispica* Mez	Bromeliaceae	N/A	PRB	9	3	2	
Tolumnia prionochila (*Kraenzl.*) *Braem*	Orchidaceae	NT	PRB	31	6	1	1
Vachellia anegadensis (Britton) Seigler & Ebinger|	Leguminosae	EN	BVI	705	1	1	1
Varronia rupicola (Urb.) Britton	Boraginaceae	EN	BVI, PR	923	1		1
Zanthoxylum flavum Vahl	Rutaceae	VU	NTROP	18	1		1
Zanthoxylum thomasianum Krug & Urb.	Rutaceae	EN	PRB	139	2	1	

SCC and < 75 records, including Jost Van Dyke which is the fourth largest island in the archipelago (8 km^2). Regional endemism was high, with 13 species endemic to the Puerto Rican Bank, seven to the Virgin Islands (BVI and USVI), four to the BVI only and four occurring in the BVI and Puerto Rico, but absent from the USVI. Species with a Neotropical or wider Caribbean distribution were also included in the SCC list (Table 1) because they are globally threatened and qualified for TIPAs

criterion Ai (globally threatened species) and Bii (species of national high conservation importance). Species richness patterns for globally threatened species, which occurred in 22 islands of the BVI, were similar to those patterns observed for SCC. The three largest islands contained higher species richness and number of records (Fig. 2), i.e. Tortola (14 globally threatened species, 132 records), Anegada (nine globally threatened species, 2192 records) and Virgin Gorda (12 globally threatened species, 390 records).

Species richness within TIPAs

The BVI TIPAs network contains 18 sites distributed across the archipelago (Fig. 1). Individual TIPAs sites varied in size from entire islands to small areas within islands, the largest being Anegada Island TIPA with 38 km^2 and the smallest Hawks Nest with 0.37 km^2. The qualifying criteria for TIPAs do not take into consideration land ownership and highly-disturbed urban areas were excluded from TIPAs boundaries.

All Species of Conservation Concern are represented across the BVI TIPAs Network with ca. 91% of all records occurring within TIPAs (Fig. 3). The only TIPA that does not have any of the SCC present is Paraquita Bay and Bar Bay TIPA which is based solely on a threatened habitat (Mangroves). The greatest number of records (Table 2) were available for Anegada Island TIPA (2206 records), followed by Central

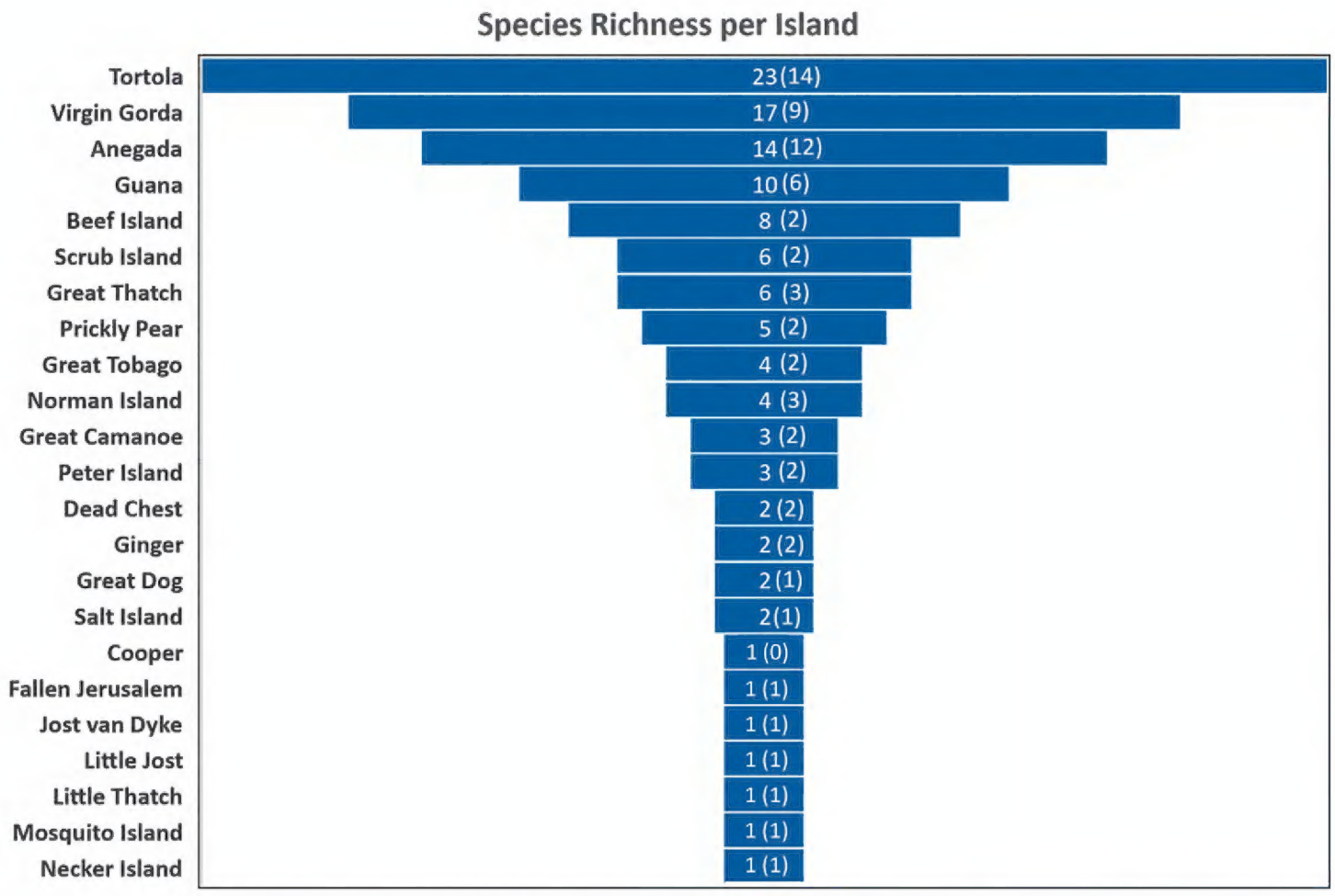

Figure 2. Species richness across the BVI archipelago. Data show number of Species of Conservation Concern (SCC) recorded in each island. Numbers in () correspond to globally threatened species.

Table 2. TIPAs Network and occurrence of Species of Conservation Concern in the British Virgin Islands. Location of TIPA in () if not contained in the TIPA name. Abbreviations: Tropical Important Plant Area site (TIPA).

Species of Conservation Concern	Anegada Island TIPA	Beef Island and the Channel TIPA	Central Virgin Gorda TIPA	Eastern Scrub Island TIPA	Eastern Virgin Gorda TIPA	Ginger Island TIPA	Great Thatch Island TIPA	Great Tobago Island TIPA	Guana Island TIPA	Hawks Nest TIPA (Tortola)	Mount Sage TIPA (Tortola)	Norman Island TIPA	Northeastern Jost van Dyke TIPA	Northern Great Camanoe TIPA	Paraquita Bay and Bar Bay TIPA (Tortola)	Prickly Pear Island TIPA	Sabbath Hill TIPA (Tortola)	Tortola North Shore TIPA	Total records within TIPAs
Agave missionum	73	9	8	33			15	20	25	3		15		2		1			204
Anthurium × selloanum											1						1		2
Argythamnia stahlii	102								1										103
Abutilon virginianum						11			10			5					3		29
Myrcia neokiaerskovii			18								14								32
Myrcia neothomasiana			14								9								23
Cedrela odorata											1								1
Croton fishlockii		14	116	9	65				1	40				10		4			259
Erythrina eggersii							4			7									11
Galactia eggersii		9	5		3		6			7									30
Guaiacum officinale	15																		15
Ilex urbaniana											21								21
Leptocereus quadricostatus	33																		33
Machaonia woodburyana			99		17														116
Malpighia woodburyana	52	16	34	1	2	3	12	1	5			33	3			12			174
Maytenus cymosa			25		8														33
Metastelma anegadense	209		3																212
Miconia thomasiana											24								24
Mitracarpus polycladus	36																		36
Peperomia wheeleri			6							1									7
Picrasma excelsa											1								1
Pilea sanctae-crucis										9	3							1	13
Piptocoma antillana			2	2				4				2							10
Pitcairnia jareckii									15	1				1					17
Psychilis macconnelliae	12	5	4	1	2		2		2	2						4			34
Reynosia guama		10	5						8	5							1	1	30
Rondeletia pilosa		5	17		5		3	3	4	5	1						2		45
Sabal causiarum	9								3									6	18
Senna polyphylla var. *neglecta*	78																		78
Tillandsia × lineatispica		4	3							1									8
Tolumnia prionochila	2		10	1	1											9	3		26
Vachellia anegadensis	644																		644
Varronia rupicola	923																		923
Zanthoxylum flavum	18																		18
Zanthoxylum thomasianum			100							23									123
Total records	2206	72	469	47	103	14	42	28	74	104	75	55	3	13	0	30	10	8	3353
Number of species	14	8	17	6	8	2	6	4	10	12	9	4	1	3	0	5	5	3	35
Globally threatened species	12	2	9	2	3	2	3	2	6	6	6	3	1	2	0	2	1	2	25

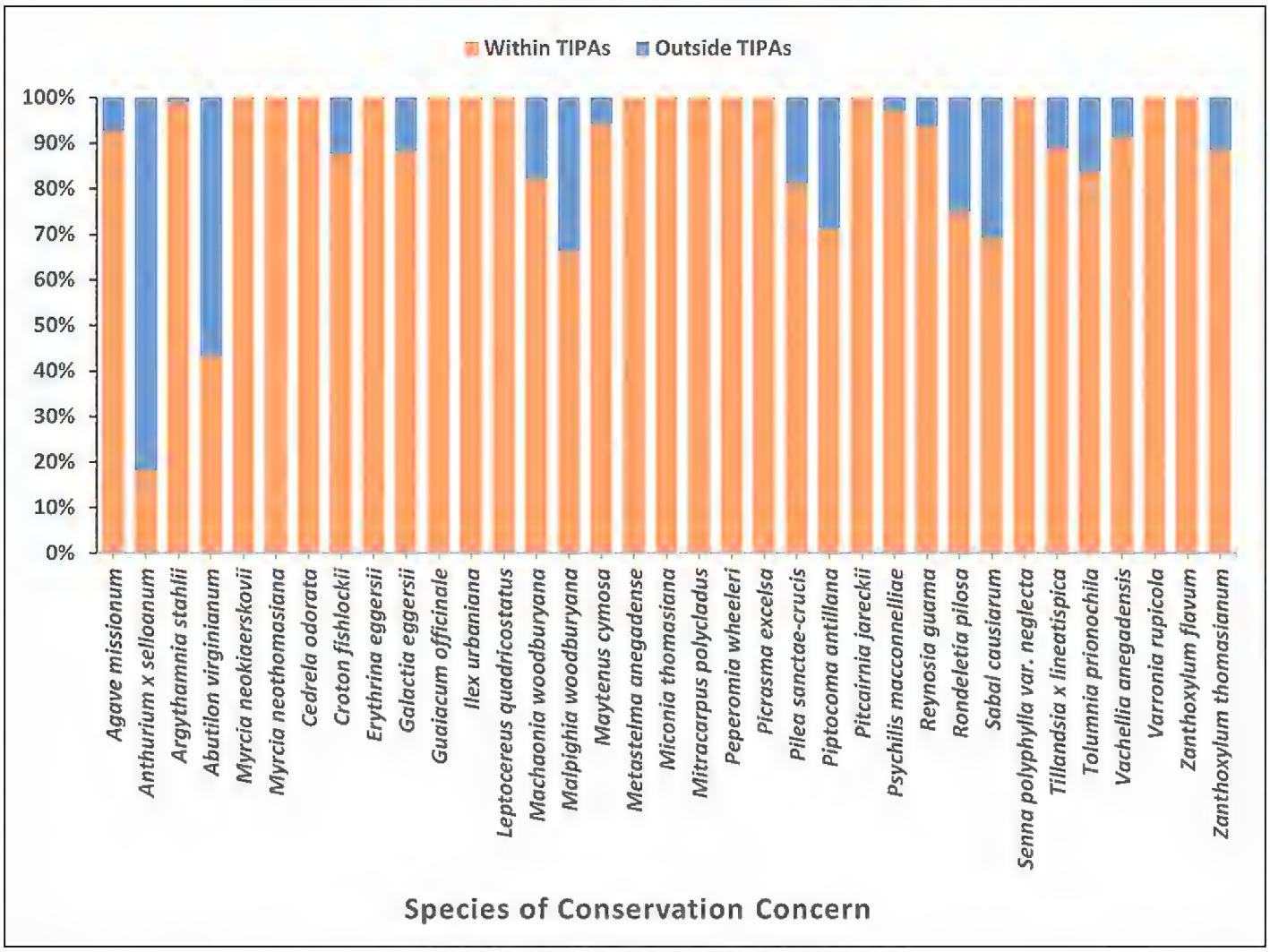

Figure 3. Representativeness of the Species of Conservation Concern within the BVI TIPAs network. Data show percentage of the records for each species that occur within or outside the TIPAs sites.

Virgin Gorda TIPA (469 records) and Hawks Nest TIPA (104 records). These TIPAs also had high species richness and several globally threatened species (Fig. 4). Interestingly, Hawks Nest TIPA on Tortola has a high SCC concentration in a small area (0.37 km^2) when compared to the largest sites on Virgin Gorda: Central Virgin Gorda TIPA and Eastern Virgin Gorda TIPA with 7.8 km^2 and 2.7 km^2, respectively.

All BVI globally threatened species are present in the BVI TIPAs Network (Table 1). Nine species have more than half of their records within TIPAs and 15 species have all their records within TIPAs, including three BVI endemic species. The other BVI endemic, *Vachellia anegadensis*, also occurs on the Island of Fallen Jerusalem which did not qualify as a TIPA, but is a National Park. The only two globally threatened species poorly represented in the TIPAs Network were *Abutilon virginianum Krapov.* (43.3%) and the natural hybrid *Anthurium* × *selloanum* K.Koch (18.2%) (Fig. 3). The two most widespread globally threatened species were *Agave missionum* Trel. and *Malpighia woodburyana* Vivaldi occurring in 11 and 12 of the TIPAs, respectively. The two rarest globally threatened species are the Neotropically-distributed *Cedrela odorata* L. and *Picrasma excelsa* (Sw.) Planch. with only one high accuracy record each on the Island of Tortola, both in Mount Sage TIPA and Sage Mountain National Park (Tables 2 and 3).

The Central Virgin Gorda TIPA is the site with the highest species richness with 17 Species of Conservation Concern (Fig. 4). None of these species is exclusive to this site.

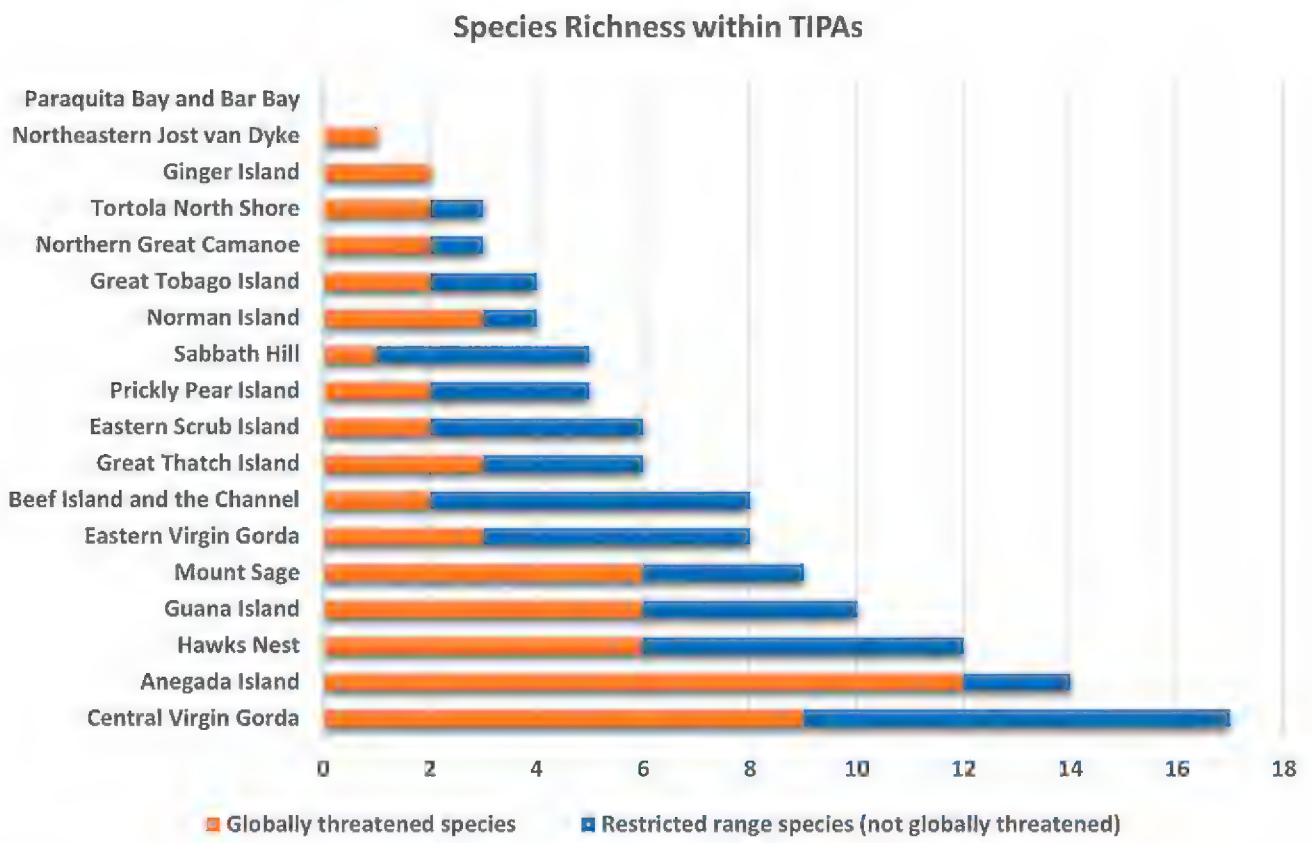

Figure 4. Species richness within the BVI TIPAs network. Data show number of Species of Conservation Concern, comprised of globally threatened species and restricted range species which are not globally threatened, in each TIPA site.

Two Puerto Rican Bank endemic species, *Myrcia neokiaerskovii* E.Lucas & K.Samra and *Myrcia neothomasiana* A.R.Lourenço & E.Lucas, are only found in the threatened Upland Evergreen Forest habitat within this TIPA and Mount Sage TIPA (Table 2). These species have, respectively, ca. 97% and 87% of their records within Gorda Peak National Park and Sage Mountain National Park (Table 3). Even though these two TIPAs sites share the same habitat type and some common species, there are important and rare plants that occur in one, but not the other. The Eastern Virgin Gorda TIPA has no exclusive species and lower species richness than the Central Virgin Gorda TIPA, but this site contains > 1% of the global population of the Puerto Rican Bank endemic *Maytenus cymosa* Krug & Urb. and > 5% of the national population of the Virgin Islands endemic *Machaonia woodburyana* Acev.-Rodr. Central Virgin Gorda TIPA is also one of the five best sites in the BVI for two nationally threatened habitats: Coastal Shrubland and Mangroves.

Half of the globally threatened species found in the Anegada Island TIPA are not present on any other island in the BVI (Table 2). This includes *Varronia rupicola* and *Leptocereus quadricostatus* (Bello) Britton & Rose, found on Anegada and Puerto Rico and the BVI endemic *Senna polyphylla* var. *neglecta*. This TIPA has the second highest species richness in the BVI with 14 Species of Conservation Concern (Fig. 4). The Island of Anegada currently lacks designated terrestrial protected areas. The only high accuracy records for *Guaiacum officinale* L. are from this Island, but the species is also reported from Guana, Jost Van Dyke, Tortola and Virgin Gorda (The BVI TIPAs National Team 2019b, 2019a). Guana Island TIPA is a species-rich site with 10 Species of Conservation Concern and almost all records for the BVI endemic *Pitcairnia jareckii*.

Table 3. National Parks and occurrence of Species of Conservation Concern in the British Virgin Islands. National Parks without any records for the species are not listed. Location of National Park in () if not entire island. † Indicates percentage instead of number of records.

	Existing National Parks (NP)												Proposed National Parks (PNP)				
Species of Conservation Concern	**Cam Bay (Great Camanoe)**	**Dead Chest Island**	**Fallen Jerusalem**	**Gorda Peak (Virgin Gorda)**	**Great Tobago**	**Little Fort (Virgin Gorda)**	**Prickly Pear**	**Sage Mountain (Tortola)**	**Shark Bay (Tortola)**	**Spring Bay (Virgin Gorda)**	**Total records within NP**	**Occurrence within NP (%)**	**Beef Island**	**Eastern Ponds (Anegada)**	**Great Dog (The Dogs)**	**Great Thatch**	**Total records within PNP**
Agave missionum	2				20		1			1	**24**	**11**		8		14	**22**
Anthurium × selloanum								1	1		**2**	**18**					
Argythamnia stahlii														1			**1**
Abutilon virginianum		3									**3**	**4**					
Myrcia neokiaerskovii				17				14			**31**	**97**					
Myrcia neothomasiana				11				9			**20**	**87**					
Cedrela odorata								1			**1**	**100**					
Croton fishlockii				13			4				**17**	**6**	14				**14**
Erythrina eggersii																4	**4**
Galactia eggersii																6	**6**
Guaiacum officinale														8			**8**
Ilex urbaniana								21			**21**	**100**					
Leptocereus quadricostatus														7			**7**
Machaonia woodburyana																	
Malpighia woodburyana		2			1		13				**16**	**6**	9	10	15	11	**45**
Maytenus cymosa				8							**8**	**23**					
Metastelma anegadense														1			**1**
Miconia thomasiana								13			**13**	**54**					
Mitracarpus polycladus																	
Peperomia wheeleri																	
Picrasma excelsa								1			**1**	**100**					
Pilea sanctae-crucis								3	1		**4**	**25**					
Piptocoma antillana					4						**4**	**29**					
Pitcairnia jareckii																	
Psychilis macconnelliae							4				**4**	**11**	5			2	**7**
Reynosia guama				1					1		**2**	**6**					
Rondeletia pilosa				2	3						**5**	**8**	2			3	**5**
Sabal causiarum									3		**3**	**12**					
Senna polyphylla var. *neglecta*														2			**2**
Tillandsia × lineatispica				1		1					**2**	**22**					
Tolumnia prionochila							9				**9**	**29**			5		**5**
Vachellia anegadensis			61								**61**	**9**		29			**29**
Varronia rupicola														36			**36**
Zanthoxylum flavum														4			**4**
Zanthoxylum thomasianum				21							**21**	**15**					
Total records	2	5	61	74	28	1	31	63	6	1	**272**	**7†**	30	106	20	40	**196**
Number of species	1	2	1	8	4	1	5	8	4	1	**22**	**63†**	4	10	2	6	**16**
Globally threatened species	1	2	1	4	2	0	2	6	2	1	**13**	**52†**	1	10	1	3	**11**

The two sites with lowest species richness, Paraquita Bay and Bar Bay TIPA on the Island of Tortola and Northeastern Jost van Dyke TIPA (Fig. 4), both qualified as a TIPA for their importance for threatened habitats, the former for its Mangroves and the latter for its Semi-deciduous Gallery Forest.

Ginger Island TIPA is also low in species richness but qualified for being one of the five best sites in the archipelago for the globally threatened *Abutilon virginianum*. This species is also present in Guana Island TIPA, Norman Island TIPA and Sabbath Hill TIPA on the Island of Tortola. Only three records for this species are within a protected area in Dead Chest National Park (Table 3) and 43% of the records are found within TIPAs (Fig. 3).

Species richness within BVI National Parks

A small proportion of all observed records were recorded in National Parks (ca. 7%) and Proposed National Parks (5.3%), occurring in only 10 of the 21 National Parks and four of the eight Proposed National Parks. In terms of species, two thirds of the Species of Conservation Concern (22 species), including nearly half of the globally threatened species (13 species), are represented in the BVI National Park System, having legal protection (Table 3). If we include Proposed National Parks to the analysis, then the number of Species of Conservation Concern increases to 31 species. However, only six of these species have > 50% of their records within National Parks. The species that had all records within National Parks were *Cedrela odorata*, *Picrasma excelsa* and *Ilex urbaniana* Loes. ex Urb., all occurring in Sage Mountain National Park on the Island of Tortola.

Five of the Species of Conservation Concern, i.e. *Argythamnia stahlii* Urb., *Guaiacum officinale*, *Senna polyphylla* var. *neglecta*, *Varronia rupicola* and *Zanthoxylum flavum* Vahl, were absent from National Parks, but occurred in the Eastern Ponds Proposed National Park on the Island of Anegada. Similarly, *Erythrina eggersii* Krukoff & Moldenke and *Galactia eggersii* Urb. are only present in the Great Thatch Proposed National Park on the Island of Great Thatch. Gorda Peak National Park on the Island of Virgin Gorda and Sage Mountain National Park on the Island of Tortola have the highest observed number of Species of Conservation Concern (eight for each), including, respectively, four and six globally threatened species. The species absent from the National Parks System were *Machaonia woodburyana*, *Mitracarpus polycladus* Urb. and *Pitcairnia jareckii*. Despite *Peperomia wheeleri* Britton occurring in Gorda Peak National Park, a lack of high-resolution records resulted in the species not being recorded in our dataset (Table 3).

Overlaps between TIPAs sites and six of the National Parks are observed on the Islands of Tortola, Virgin Gorda, Prickly Pear and Great Camanoe (Fig. 1). Another three Proposed National Parks overlapped with TIPAs on Beef Island, Great Thatch and Anegada.

Discussion

Data and species distribution

Records from non-georeferenced sources or those georeferenced, but without the required high accuracy (+/- 10 m), were not considered in the analysis, thus improving

standardisation and increasing confidence in the results. Herbarium vouchers and/or photographs accompanied most records. Field surveys conducted by those familiar with the species and trained botanists ensured correct plant identifications. As not all islands of the BVI archipelago could be surveyed in the given project timeframe (2016–2019), gap analysis and consultation with partners ensured the dataset had a representative coverage across the archipelago. Measures applied to avoid data duplication included the use of high accuracy data in the analysis, filtering and checking records before retrieval from the main database, gap analysis, planned fieldwork targeting new areas and use of hand-held computers with GPS during fieldwork to visualise previously-recorded observations. Combining all data from herbarium vouchers and field observations into one dataset and incorporating them into the GIS also enabled us to check and visualise data for any possible errors and duplications. The dataset used for the identification of TIPAs and analysed here is for the 35 Species of Conservation Concern occurring across 23 of the BVI islands, so it does not represent the complete botanical richness of each island, TIPA or National Park. Having an initial target list of priority species with all the known regional (Puerto Rican Bank) and national endemic native plant species enabled focused field surveys and a robust dataset for assessing the current threats and extinction risk for these species.

There was large variation in the numbers of records for each species (1–923) and per island (1–2206) because of the various sources of data used in this analysis, sampling effort and site botanical richness. Anegada Island, in particular, had a large amount of data available (2206 records) due to previous, focused research on *Vachellia anegadensis* (Bárrios 2015; Bárrios et al. 2021), *Varronia rupicola* (Hamilton 2016) and other threatened species, such as *Argythamnia stahlii* and *Metastelma anegadense* (Linsky 2014). This explains the high number of records for this Island and these species in this analysis. Several other species have also been the focus of survey and sampling efforts, particularly national and regional endemics.

The number of Species of Conservation Concern and globally threatened species per island did not relate directly to land area, as we observed that some small islands have greater species richness for these categories than larger islands, for example, Guana and Jost van Dyke (Fig. 2). Besides possible sampling bias, other factors, such as history of management and habitat intactness because of urban development, invasive species and feral grazing, are more likely to affect species composition than size alone. Guana Island has been privately owned since 1935 and is mostly undeveloped with feral grazing animals removed in the past (goats) or being controlled (sheep) (Mayer and Chipley 1992; Island Resources Foundation 2015a). On the other hand, Jost van Dyke is more developed with a higher level of disturbance from feral grazing and invasive alien species (Island Resources Foundation and Jost Van Dykes (BVI) Preservation Society 2009), both of which have negative impacts on native plant species persistence and discovery during surveys.

Species richness and conservation within TIPAs and National Parks

More than 66% of the Tropical Dry Forests of the Caribbean are estimated to have already been lost and native species richness and population numbers reduced (IPBES

2018). Botanical data, such as those presented here, are urgently needed to guide efforts to limit further biodiversity loss. The aim of the TIPAs framework is to identify a network of areas that represent the most important sites for the conservation and management of species of global and or local conservation concern for a specific region or country/territory (Darbyshire et al. 2017). This target was achieved through the identification of the BVI TIPAs Network, as its sites are well distributed across the archipelago (Fig. 1) and all Species of Conservation Concern are represented. All globally threatened species, apart from *Abutilon virginianum*, have > 50% of their high-resolution records within TIPAs and 15 species have all available high-resolution records within TIPAs. The TIPAs criterion A(i) aims to capture areas that contain > 1% of the global population or > 5% of the national population of a globally threatened species (Darbyshire et al. 2017), resulting in a good representation of species across the TIPAs Network. The four BVI endemic species are well represented within TIPAs, but that is not the case within the current BVI Protected Areas System Plan 2007–2017. *Vachellia anegadensis* is the only BVI endemic plant species present in a Protected Area as it occurs within the Fallen Jerusalem National Park. However, most of its population (> 90%) is found on the Island of Anegada, which currently has no designated terrestrial protected areas.

Data showed that the Island of Anegada has the highest number of Species of Conservation Concern in the BVI. The Anegada Biodiversity Action Plan (2003–2006) (McGowan et al. 2006) identified 288 native plant species for the Island with 4% of them being endemic to the Puerto Rican Bank Floristic Region. This species richness and endemism can be partially explained by the Island's geological history, which is unique for the BVI. While all the other islands in the BVI are of volcanic origin, Anegada is formed completely of limestone (Gore 2013). Another factor is that the Island is mostly undeveloped. The major threat for most plant species on the Island is grazing by feral animals with numerous cows, sheep, goats and donkeys roaming free; however, invasive insect pests are an increasing threat to the flora (Malumphy et al. 2015; The BVI TIPAs National Team 2019b). McGowan et al. (2006) suggested the establishment of a protected area network to protect key habitats and species on the Island and land zoning to protect critical habitats across the Island. Two areas were proposed in the BVI Protected Areas System Plan (2007–2017) for this Island, the Eastern Ponds Proposed National Park and the Western Ponds Protected Landscape, both already identified as RAMSAR sites (Gardner et al. 2008). The addition of these two areas to the BVI protected area network would increase the number of species under protection, although the largest part of the populations would remain outside these areas and under potential threat. The identification of the whole Island as a TIPA site indicates the importance of considering a wider approach, such as inclusion of additional areas during any future revision of the BVI Protected Areas System Plan or private nature reserves.

The current BVI National Parks System does not hold a good representation of the Species of Conservation Concern, with species completely absent or only a small number of individuals present (Table 3). It has been shown that protected ar-

eas globally fall short on having a representative coverage of biodiversity and future expansions should take that into account for effective conservation (Butchart et al. 2015). The small number of SCC individuals present in the current BVI National Parks System undoubtedly means the system does not capture the full genetic diversity of most of the species. Studies have shown that fragmentation, reduction in population size and loss of genetic diversity can affect species fitness and survival rates (Reed and Frankham 2003; Frankham 2005). This is cause for concern due to the increasing pressures these species face because of urban development, habitat fragmentation, feral grazing, encroachment of invasive species and climate change. More than 40 invasive insect pests were observed in the BVI during a rapid survey by Malumphy (2017) and > 260 species of invasive plants have been recorded so far with 18 of them flagged as the most serious (The BVI TIPAs National Team 2019b). Invasive species are a regional and global problem which drives population declines and species extinctions and can lead to major socio-economic impacts (Kairo et al. 2003; Reaser et al. 2007; Vilà et al. 2011).

Two National Parks, Great Tobago and Prickly Pear, which qualified as TIPAs for their botanical richness and occurrence of Species of Conservation Concern, are under extreme environmental pressure despite legal protection. Both areas have been heavily grazed by feral animals and invasive species are displacing native vegetation (The BVI TIPAs National Team 2019b). This highlights that alongside legal protection, resources for management and enforcement are a necessary long-term commitment. Protocols for invasive plant species eradication and long-term monitoring of the vegetation recovery after feral animal eradication have been established and require long-term resourcing (Hamilton et al. 2019).

Global evidence suggests that inaccessible areas, such as steep cliffs and ghuts, exhibit higher species richness and are home to several rare species (Norder et al. 2020). This is the case of Hawks Nest TIPA on Tortola. Most of the area, mixed Crown and private land, is undeveloped due to its steep and rugged hillsides which prevented earlier settlements and plantations. Development of the land within this TIPA could lead to clearing of the vegetation and possible loss of genetic diversity and reduction of population numbers for several important species. Two Puerto Rican Bank endemic species, *Erythrina eggersii* and *Zanthoxylum thomasianum* Krug & Urb. and the Virgin Islands endemic *Pilea sanctae-crucis* Liebm. could be particularly affected as they only occur in a few locations in the BVI. Research is needed to evaluate the importance of the various sites containing individuals for the conservation of their genetic variability. Land swaps could provide an option for retaining unique habitat in the BVI.

Sage Mountain National Park on Tortola and Gorda Peak National Park on Virgin Gorda are, respectively, within Mount Sage TIPA and Central Virgin Gorda TIPA. These sites have a high number of Species of Conservation Concern. Settlements on both Islands date to Pre-Colombian times and European colonisation in the 17th century led to large-scale deforestation for plantations and urbanisation in the following century. Presently, these Islands are home to most of the BVI hu-

man population, Tortola 83% and Virgin Gorda 14% (Island Resources Foundation 2012, 2015b). The early recognition by the BVI Government of these areas as important sites for soil and watershed management, conservation of Caribbean forests and tourism and recreation led to their designation as National Parks as early as 1964 for Sage Mountain (Forestry Area since 1955) and 1974 for Gorda Peak (Gardner et al. 2008). This ensured a level of protection of the local flora and rare Upland Evergreen Forest threatened habitat, which only occurs in these two areas of the BVI due to their higher altitudes (up to 526 m) and moister environment (The BVI TIPAs National Team 2019b). Besides legal protection, several taxa require species management plans to monitor threats and create *ex situ* collections to ensure future survival. For example, *Myrcia neokiaerskovii* and *Myrcia neothomasiana* are only found in these two National Parks in the BVI. Both have a small number of individuals and are currently threatened by several invasive scale insects (Malumphy et al. 2019) and the impacts of climate change, making them susceptible to extinction. The fragility of small populations, regardless of their location in relation to National Park boundaries, highlights the need for on-going monitoring and securing these species in *ex situ* collections (Hamilton et al. 2017; Clubbe et al. 2020). Genetic diversity and representation in *ex situ* collections are important to prevent genetic erosion and inbreeding, maximise the potential for future re-introductions and species management interventions (Lauterbach et al. 2012; Hoban and Strand 2015; Wood et al. 2020). Regional collaborations are also important for understanding species genetic diversity across borders and implementing species management plans.

Pathway to future plant conservation in the BVI and Caribbean

Surveys of Caribbean conservation organisations revealed an existing knowing-doing gap for more effective local conservation (Jacobs et al. 2016). The BVI TIPAs process was able to bridge the gap between practitioners and scientists by including both groups, not only in decision-making, but also data gathering and sharing. Robust georeferenced data for Species of Conservation Concern, globally threatened species and threatened habitats of the BVI have been made available through this process for *in situ* and *ex situ* plant conservation, enabling targeted and more focused species management, recommendations during revision of physical planning applications and development of environmental policy. Hawks Nest TIPA on Tortola is a good example of an area previously not well documented and where a high number of Species of Conservation Concern were recorded through field surveys during the TIPAs process. These new data highlighted the area as a priority for monitoring and management of several globally threatened species, including *Zanthoxylum thomasianum*. Since then, further surveys of *Z. thomasianum* in the area increased the number of known individuals and contributed samples for genetic studies. This species is now being monitored regularly on Tortola and Virgin Gorda. *Ex situ* conservation via seed collections and propagation at J.R. O'Neal Botanic Gardens on Tortola is underway. Furthermore, threatened

species data for Hawks Nest TIPA have been crucial and timely to make informed decisions on recent planning applications to develop part of the area.

The role of the BVI National Parks as an education resource to engage the local communities (Smith-Abbott et al. 2002) have been applied to the BVI TIPAs through workshops, field guides and interpretation panels delivered via the TIPAs process (The BVI TIPAs National Team 2019a, 2019b). Research has shown that the local communities tend to a passive attitude towards conserving biodiversity in protected areas, but that can be changed by engagement and livelihood projects (Watson et al. 2014; Tumbaga et al. 2021). In the future, boundary organisations can be engaged to maximise awareness and participation in plant conservation efforts in the BVI via such initiatives.

Ideally, the integration of the TIPAs network into a revised BVI Protected Areas System Plan under National Parks or other management categories would be highly beneficial for the future conservation of the Species of Conservation Concern and threatened habitats in the BVI, helping minimise biodiversity loss and improving species management and monitoring of threats, such as invasive species. However, this approach is neither practical nor feasible as some TIPAs sites are entire islands and or private property. A focused assessment on what areas within the TIPAs network should be declared as protected areas is required to ensure a certain percentage of the Species of Conservation Concern and the threatened habitats identified are protected. In the Republic of Guinea, researchers are working with the local government to integrate some of the TIPAs into the protected areas system, safeguarding and benefitting, not only local flora, but also fauna as the areas are under severe threat (Couch et al. 2019b). Intact habitats show resilience to natural disasters, as observed in the BVI after the category 5 Hurricane Irma ravaged the islands in 2017 (Hamilton and Clubbe 2018). Caribbean Dry Forests have evolved to withstand and recover after hurricane events (Van Bloem et al. 2006). Such resilience has significant impacts, not only in the maintenance of species diversity and ecosystem services (e.g. reducing soil erosion, food for fauna), but also indirect socio-economic benefits, such as ecotourism.

Despite the benefits of *in situ* conservation, there are limitations in terms of resources required, land ownership and local interests. Locations of global protected areas show a bias towards higher elevations, steeper slopes, lands of lower productivity and economic worth and low human density and are often not representative of local biodiversity. Expansions driven by Aichi Target 11 can only change this scenario if threatened species distributions are considered and trade-offs of costs and benefits properly managed (Watson et al. 2014). As discussed previously, legal protection alone is not enough to ensure species survival, as many of the Species of Conservation Concern are found outside the Protected Areas System or are under threat by feral grazing and/or invasive species. The TIPAs process in the BVI delivered spatial data and extinction risk assessments for the Species of Conservation Concern and threatened habitats, which can be used to help provide information for development planning during the Environmental Impact Assessment process, minimising further biodiversity loss. A combined plan of *in situ* and *ex situ* conservation is the best approach to maximise resources and prevent loss of genetic diversity and species extinctions. *Ex situ* col-

lections for threatened and/or endemic species of the BVI and the Puerto Rican Bank Floristic Region have been developed over recent years (Gdaniec and Hamilton 2017; Hamilton et al. 2017), but much needs to be done to fully evaluate the impact of such collections on species conservation and reduction of biodiversity loss.

Knowledge of the status and distribution of botanical resources is important for good conservation decision-making and to meet international targets set in Multi-Lateral Environmental Agreements (CBD 2011; GSPC 2021). Clubbe, Hamilton and Corcoran (2010) identified the GSPC as an important document for plant conservation in the UKOTs and much has been achieved so far towards delivering Targets 1 (checklist) and 2 (Red List) for each Territory (Clubbe et al. 2020). TIPAs form the basis of Target 5 of the GSPC and also align with Key Biodiversity Areas (KBAs), which are sites contributing significantly to the global persistence of biodiversity (IUCN 2016). The identification of TIPAs, using comprehensive scientific data specific to the BVI, has identified gaps in the existing BVI Protected Areas System Plan and will contribute to an updated version of the System Plan using the criteria for protected area designation. Further survey work could identify core areas of plant species abundance and diversity which would help to refine TIPAs boundaries, particularly where whole islands are currently identified as TIPAs. Combining these detailed plant data with genetic data available for threatened species, vegetation maps and data on other key taxa, such as birds, amphibians, reptiles and invertebrates can further refine site selection for new protected areas. The identification of TIPAs within the BVI can also provide information for the creation of Environmental Protection Areas (EPAs) under the Physical Planning Act (Government of the Virgin Islands 2004). Development would be strictly controlled in these areas and would have to comply with permitted use activities. This would assist the BVI in meeting the Sustainable Development Goals target 15.5, which aims to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species (United Nations 2021).

All available botanical data for native and invasive species in the BVI generated through this work have been shared with BVI partners to be integrated into the National Geographic Information System (GIS) and is curated through the Kew UKOTs SSD (UKOTsTeam 2021). A complete analysis of all botanical data available for the BVI could reveal biogeographical patterns, provide information for extinction risk assessments, biodiversity conservation and species management in the future and should be considered a priority.

Conclusion

The TIPAs model developed for the BVI, the first of its kind in the Caribbean, has been successful in identifying and mapping plant species of national and global conservation concern and areas important for plant conservation in the BVI. The robust and extensive botanical dataset generated was used to deliver native species identification and distribution, provide information for extinction risk assessments and the identi-

fication of TIPAs. The integration of this resource into the National GIS of the BVI and access by local practitioners and policy-makers can help guide and focus future conservation efforts and resources, facilitating species management and recovery efforts. This model has wider applications across the Caribbean, particularly to other UK Overseas Territories. Discussions held at the international TIPAs workshop in April 2019 on Tortola, BVI, highlighted the potential and benefits that the identification of TIPAs can have to deliver robust data for conservation management and action across the Caribbean Region (The BVI TIPAs National Team 2019a).

Data analysed here have highlighted the importance of the BVI National Parks System for plant and ecosystem conservation. However, the BVI TIPAs network has identified areas outside of the existing Protected Area Network that require protection measures to be put in place to conserve globally threatened plant species and habitats. Data on the Species of Conservation Concern and the TIPAs network will be important in addressing gaps and providing information for the current revision of the BVI Protected Areas System Plan and physical planning applications.

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Declarations

This research was funded by the HSBC 150th Anniversary Fund. The authors declare that they have no conflict of interest. Data were obtained with approval of the Virgin Islands Government via the National Parks Trust of the Virgin Islands.

Credits

All authors whose names appear on the submission: 1) made substantial contributions to the conception or design of the work; or the acquisition, analysis or interpretation of data; 2) drafted the work or revised it critically for important intellectual content; 3) approved the version to be published; and 4) agree to be accountable for all aspects of

the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The full datasets generated during and/or analysed during the current study are not publicly available due to the need to protect precise locations of threatened species, but are available from the corresponding authors on reasonable request. Vetted data for the BVI TIPAs Network are publicly available via the Kew Tropical Important Plant Areas Explorer (https://tipas.kew.org).

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